Electroanalysis 2018 vol.30 N9, pages 2053-2065

Description of Complex Fluids Electrochemical Data in the Frame of Percolation Model

Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

© 2018 Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim In the paper, the percolation model (PM) developed earlier for description of data associated with complex fluids was successfully applied. As an example, we analyzed the virgin olive oil electrochemical data. In spite of the fact that this complex fluid as olive oil contains more than 100 different chemical components, it becomes possible to describe the dependencies J(U) (defined in electrochemistry as the voltammograms (VAGs)) in terms of the percolation model. This model takes into account the behavior of the conducting/percolation currents in meso-region and dependencies of the fractal dimension versus applied potential U. It was proved that this model was applicable for three basic regions: cathode region (where positive charges are mainly concentrated), capacitor (Faraday) region and anode region (where negative charges were mainly located). For these three basic conventional regions known in electrochemistry, we obtained the excellent coincidence of the fitting function obtained in the frame of PM with experimental data. These results prove that this meso-model can be applicable for description of wide set of data including different complex solutions and fluids.

http://dx.doi.org/10.1002/elan.201800264

Keywords

Fractal Dimension, Multisensor System, Percolation Model, Voltammetry

References

[1] H. C. Budnikov, V. I. Shirokova, J. Anal. Chem. 2013, 68, 663–670

[2] H. C. Budnikov, J. Anal. Chem. 1996, 51, 374–383

[3] Ya. Labuda, J. Anal. Chem. 1990, 45, 445–455

[4] N. V. Shvedene, O. N. Grebneva, Vestn. Moscow. Univers. Ser. 2, Khimiya. 1995, 5, 466–470

[5] G. Erdegdou, J. Anal. Chem. 2003, 58, 632–635

[6] L. G. Shaidarova, A. V. Gedmina, H. C. Budnikov, J. Anal. Chem. 2003, 58, 193–198

[7] H. Z. Brainina, N. Yu. Stozhko, J. V. Shalygina, J. Anal. Chem. 2004, 59, 843–850

[8] A. M. Gevorgyan, S. V. Vakhnenko, A. T. Artykov, J. Anal. Chem. 2004, 59, 417–420

[9] H. C. Budnikov, G. A. Evtyugin, E. P. Rizaeva, A. N. Ivanov, V. Z. Latypova, J. Anal. Chem. 1999, 54, 973–982

[10] L. Moreno-Baron, R. Cartas, A. Merkoc, S. Alegret, M. de Valle, L. Leija, P. R. Hernandez, R. Munoz, Sensor. Actuat. B-Chem. 2006, 113, 487–499

[11] E. G. Kulapin, V. V. Baraguzin, O. I. Kulapina, J. Anal. Chem. 2004, 59, 971–975

[12] N. A. Gavrilenko, G. M. Mokrousov, O. V. Giganskaya, J. Anal. Chem. 2004, 59, 967–970

[13] G. A. E. Mostafa, J. Anal. Chem. 2003, 58, 1196–1199

[14] B. P. Nikol′skiy, Ye. A. Materova, Ionselektivnyye elektrody, L.: Khimiya, 1980, 240 p
[15] A. Kutyła-Olesiuk, U. E. Wawrzyniak, M. Jańczyk, W. Wróblewski, Procedia Eng. 2014, 87, 580–583
[16] X. Cetó, C. Apetrei, M. del Valle, M. L. Rodríguez-Méndez, Electrochim. Acta. 2014, 120, 180–186
[17] X. Cetó, J. M. Gutiérrez, A. Mimendia, F. Céspedes, M. del Valle, Electroanalysis 2013, 25, 1635–1644
[18] J. M. Gutiérrez, Z. Haddi, A. Amari, B. Bouchikhi, A. Mimendia, X. Cetó, M. del Valle, Sensor. Actuat. B-Chem. 2013, 177, 989–996
[19] H. Xiao, J. Wang, J. Food Agric. Environ. 2012, 10, 227–230
[20] H. Men, Z. Ge, Y. Guo, L. An, Y. Peng, Pro. Int. Conf. CEAMTMA. 2009, 10, 621–624
[21] L. Sipos, Z. Kovács, V. Sági-Kiss, T. Csiki, Z. Kókai, A. Fekete, K. Héberger, Food Chem. 2012, 135, 2947–2953
[22] F. Winquist, J. Olsson, M. Eriksson, Anal. Chim. Acta. 2011, 683, 192–197
[23] I. Campos, M. Alcañiz, D. Aguado, R. Barat, J. Ferrer, L. Gil, M. Marrakchi, R. Martínez-Máñez, J. Soto, J. L. Vivancos, Water Res. 2012, 46, 2605–2614
[24] I. Campos, A. Sangrador, R. Bataller, D. Aguado, R. Barat, J. Soto, R. Martínez-Máñez, Electroanalysis 2014, 26, 588–595
[25] N. Liu, Y. Liang, J. Bin, Z. Zhang, J. Huang, R. Shu, K. Yang, Food Anal. Method. 2014, 7, 472–480
[26] I. Yaroshenko, D. Kirsanov, L. Kartsova, N. Bhattacharyya, S. Sarkar, A. Legin, Sensor. Actuat. B-Chem. 2014, 191, 67–74
[27] E. Várvölgyi, A. Gere, D. Szöllősi, L. Sipos, Z. Kovács, Z. Kókai, M. Csóka, Zs. Mednyánszky, A. Fekete, K. Korány, Arabian J. Sci. Eng. 2015, 40, 125–133
[28] S. Buratti, N. Sinelli, E. Bertone, A. Venturello, E. Casiraghi, F. Geobaldo, Sensors. 2014, 95, 2192–2200
[29] M. Gutiérrez-Capitán, J. L. Santiago, J. Vila-Planas, A. Llobera, S. Boso, P. Gago, M. C. Martínez, C. Jiménez-Jorquer, J. Agric. Food Chem. 2013, 61, 9325–9332
[30] K. Tiwari, B. Tudu, R. Bandyopadhyay, A. Chatterjee, J. Food Eng. 2013, 117, 205–210
[31] Z. Wei, J. Wang, Comput. Electron. Agr. 2014, 108, 112–122
[32] M. Bougrini, K. Tahri, Z. Haddi, N. El Bari, E. Llobet, N. Jaffrezic-Renault, B. Bouchikh, Mat. Sci. Eng. C. 2014, 45, 348–358
[33] Y. Yu, H. Zhao, R. Yang, G. Dong, L. Li, J. Yang, T. Jin, W. Zhang, Y. Liu, Int. J. Electrochem. Sci. 2015, 10, 4381–4392
[34] A. Legin, A. Smirnova, A. Rudnitskaya, L. Lvova, E. Suglobova, Yu. Vlasov, Anal. Chim. Acta. 1999, 385, 131–135
[35] C. Apetrei, I. M. Apetrei, S. Villanueva, J. A. de Saja, F. Gutierrez-Rosales, M. L. Rodriguez-Mendez, Anal. Chim. Acta. 2010, 663, 91–97
[36] I. M. Apetrei, C. Apetrei, Comput. Electron. Agr. 2014, 108, 148–154
[37] I. M. Apetrei, C. Apetrei, Food Res. Int. 2013, 54, 2075–2082
[38] P. Oliveri, M. A. Baldo, S. Daniele, M. Forina, Anal. Bioanal. Chem. 2009, 395, 1135–1143
[39] Z. Haddi, M. Boughrini, S. Ihlou, A. Amari, S. Mabrouk, H. Barhoumi, A. Maaref, N. El Bari, E. Llobet, N. Jaffrezic-Renault, B. Bouchikhi, Sensors, 2012 IEEE. 2013, 1–4
[40] M. Bougrini, K. Tahri, Z. Haddi, T. Saidi, N. El Bari, B. Bouchikhi, J. Sensors. 2014, 1–10
[41] H. Men, D. Chen, X. Zhang, J. Liu, K. Ning, J. Sensors. 2014, 1–7
[42] R. R. Nigmatullin, H. C. Budnikov, A. V. Sidelnikov, Yu. A. Yarkaeva, New J. Chem. 2017, 41, 2561–2573
[43] R. R. Nigmatullin, H. C. Budnikov, A. V. Sidelnikov, E. I. Maksyutova, Madridge J. Anal. Sci. Instrum. 2017, 2, 47–55
[44] R. R. Nigmatullin, H. C. Budnikov, A. V. Sidelnikov, E. I. Maksyutova, RJMCS. 2017, 1, 1–16
[45] R. R. Nigmatullin, H. C. Budnikov, A. A. Khamzin, A. V. Sidelnikov, E. I. Maksyutova, New J. Chem. 2018, 42, 465–475
[46] R. R. Nigmatullin, H. C. Budnikov, A. V. Sidelnikov, Chaos Solitons Fractals 2018, 106, 171–183
[47] R. R. Nigmatullin, G. Maione, P. Lino, F. Saponaro, W. Zhang, Commun. Nonlinear Sci. 2017, 42, 324–341
[48] R. R. Nigmatullin, W. Zhang, R. Yang, Y. Lu, G. Maione, Comp. Commun. Collab. 2017, 5, 8–34
[49] M. J. Moyano, F. J. Heredia, A. J. Merendez-Martinez, Compr. Rev. Food Sci. Food Saf. 2010, 9, 278–291